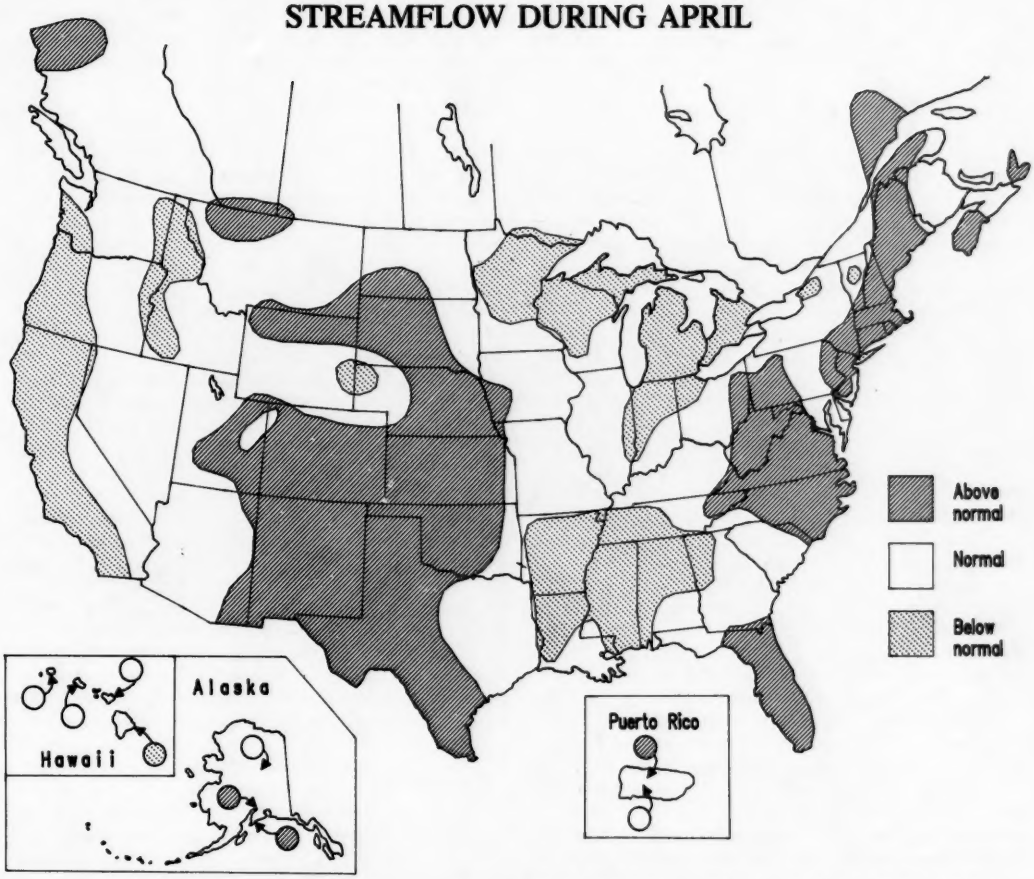
National Water Conditions

UNITED STATES
Department of the Interior
Geological Survey

CANADA
Department of the Environment
Water Resources Branch

APRIL 1987

STREAMFLOW DURING APRIL



Heavy rains combined with melting snow to cause record flooding in Maine, which was declared a Federal disaster area on April 8. Preliminary damage estimates were over $60 million. Record floods also occurred in Florida and some flooding occurred in southern Virginia.

The level of North Dakota's Devils Lake will probably reach a 1987 seasonal maximum higher than any recorded in this century, according to a National Weather Service (NWS) prediction.

The Governor of Idaho declared a state of emergency in Ada, Canyon, Elmore, Washington, Blaine, and Adams counties in anticipation of a water shortage for irrigation this summer.

An April 16 landslide on the west bank of the Snake River Canyon near Hagerman, Idaho, caused about $1.5 million damage to a pumping plant and also damaged the Hagerman fossil beds, which are considered to be the most complete assemblage of Pliocene fauna in the world.

Mean April elevations for the Great Lakes (provisional data from National Ocean Service) were lower than those for last April but remained above median.

The level of Utah's Great Salt Lake fell 0.15 foot during April, reaching 4,211.70 feet above NGVD of 1929 on April 30.

April precipitation (provisional data from NWS) was below normal over most of the United States, but was well above normal in parts of New Mexico and adjacent States, part of Kansas, and several areas in the East.

Contents of 89 percent of reporting reservoirs were near or above average for the end of April, compared with 87 percent for the end of March.

The combined flow of the 3 largest rivers in the lower 48 States—Mississippi, St. Lawrence, and Columbia—averaged 1,396,900 cfs during April, 0.2 percent below median, and 3.1 percent below last month's flow.

SURFACE-WATER CONDITIONS DURING APRIL 1987

Heavy rains, beginning March 30, combined with melting snow to cause flooding in much of New England. The worst floods occurred in Maine (see map on page 3), which was declared a Federal disaster area on April 8. Preliminary damage estimates in Maine were over $60 million after peak discharges (see table on page 3) at stream-gaging stations on the Piscataquis, Sebec, Sandy, Sebasticook, and Little Androscoggin rivers exceeded both those of record and also those for the 100-year flood. Peaks of record also occurred at 10 other stream-gaging stations in Maine and New Hampshire. Record floods also occurred at four sites in Florida (see map and table) March 30–April 3, but no damages were reported. Flooding in southern Virginia, particularly in the vicinity of Richmond, caused some damage but recurrence intervals for peak discharges did not exceed 25 years.

The level of North Dakota's Devils Lake was at 1,428.1 feet above National Geodetic Vertical Datum (NGVD) of 1929 on April 29, only 0.04 foot below the maximum recorded in this century (1983). The National Weather Service (NWS) predicts that lake level will reach a 1987 seasonal maximum elevation of about 1,429.5 feet above NGVD of 1929, as measured at the U.S. Geological Survey gage, sometime in May or June. The predicted level would exceed the 20th- century maximum, but would be 8.9 feet below the observed high of 1,438.4 feet above NGVD of 1929 in 1867. Tree-growth studies conducted in the late 19th century indicated that lake level was about 1,446 feet above NGVD of 1929 around 1830 (and lower thereafter), some 7.6 feet above the recorded high. The minimum lake level recorded was 1,400.9 feet above NGVD of 1929 in 1940.

In contrast, the Governor of Idaho declared a state of emergency in Ada, Canyon, Elmore, Washington, Blaine, and Adams counties in anticipation of a water shortage for irrigation this summer. Precipitation for the 1987 water year through March 31 was only 47 percent of normal for the Boise River basin and 58 percent of normal for the State of Idaho. April precipitation ranged from 32 percent (0.38 inch) of normal at Boise to 64 percent (0.72 inch) of normal at Lewiston, according to provisional NWS data. Snowpack measurements made by the Soil Conservation Service on April 1 were less than half of normal for that date. Preliminary results of the May 1 snow survey show conditions even further below normal. Runoff from the existing snowpack has been reduced by above-normal spring temperatures. Variations in daily temperatures (warm during the day and cool at night) have been such that snow has been melting at a rate of only 0.2 to 0.4 inches per day. Normal temperature variation (about 70 degrees during the day and above freezing at night) would produce runoff of 0.75 to 1.0 inches per day. The current dry spell could result in flows lower than those for the 1977 drought and comparable with those for the record drought of 1933-34 unless above-normal rainfall occurs. (See Palmer Drought Severity maps and article on pages 14–15, and May–July outlook maps on page 19.)

On April 16, a landslide occurred on the west bank of the Snake River Canyon near Hagerman, in south-central Idaho (about 30 miles west-northwest of Twin Falls). The landslide caused an estimated $1.5 million damage to the Bell Rapids Irrigation Company's pumping plant and an undetermined amount of damage to the Hagerman fossil beds on Bureau of Land Management property located downslope. The pumping plant is one of two in the area that lift water from the Snake River several hundred feet to irrigate about 36,000 acres of farmland on the plateau above the canyon. The fossil beds are of major paleontological value and are considered to be the most complete assemblage of Pliocene fauna in the world. Both the Smithsonian Institution and the National Geographic Society have conducted major digs at this site. The slide was probably caused by the long-term buildup of a locally perched aquifer in fine-grained sedimentary material above a thin layer of basalt. Movement occurred when the cohesiveness of the saturated mass was overcome by gravity. Recharge to the perched aquifer is by seepage from unlined irrigation canals that convey the water pumped from the Snake River. Hydraulic gradients indicate some of the water in the perched system moves toward the canyon where it discharges as springs in the canyon wall above the fossil beds. Several small slides or slumps have occurred in that area in the past.

April streamflow generally decreased seasonally in Nebraska, Louisiana, Mississippi, Alabama, Georgia, the Carolinas, and Maryland; decreased contraseasonally in Nevada, Texas, Oklahoma, the Dakotas, and Saskatchewan, and decreased variably in Arkansas and Michigan. Streamflow remained unchanged in New Mexico, and changed variably in Washington, California, Arizona, Kansas, Missouri, Wisconsin, Tennessee, and Florida. Flow increased in the rest of southern Canada and the United States; variably in Hawaii, Iowa, and Illinois; contraseasonally in Connecticut, New Jersey, Pennsylvania, Virginia, West Virginia, Ohio, and Indiana, and seasonally in all other areas. Streamflow was in the normal to above-normal range at about 76 percent of the 189 reporting index stations in southern Canada, the United States, and Puerto Rico, compared to the 66 percent in those ranges for last month. New April maximums occurred at nine streamflow index stations (see table on page 5) but only one new April minimum occurred. Hydrographs of streamflow at 8 index stations for the 26 months ending April 1987 are shown on page 13.

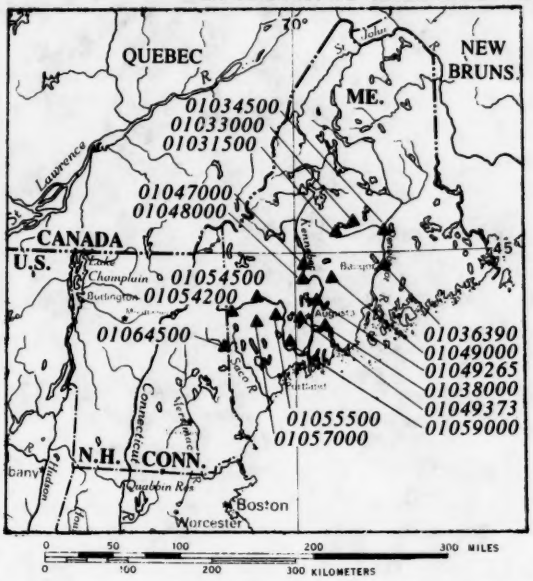
Mean April elevations for the Great Lakes (provisional data from National Ocean Service) were lower than those

(continued on page 5)

CONTENTS

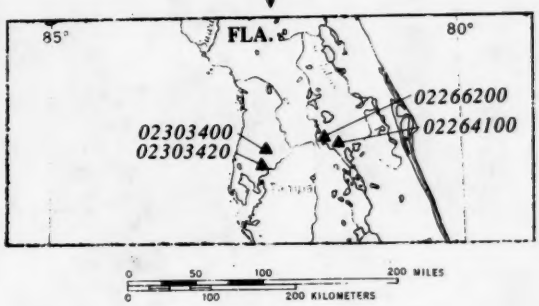
	Page
Streamflow (map)	1
Surface-water conditions	2
Streamflow persistence/change (map)	4
Summary of streamflow	4
New extremes	5
Great Lakes elevations (graphs)	6
Fluctuations of the Great Salt Lake, February 1981–April 1987 (graph)	6
Total precipitation and percentage of normal precipitation (maps)	7
Usable contents of selected reservoirs (graphs)	8
Usable contents of selected reservoirs	9
Hydrographs for the "Big 3" rivers—combined and individual flows (graphs)	10
Dissolved solids and water temperatures at downstream sites on five large rivers	10
Flow of large rivers	11
Streamflow persistence/change January–February, and February–March (corrected maps)	12
Monthly mean discharge of selected streams (graphs)	13
The Drought Severity (Long Term, Palmer) Index	14
Drought severity index by division (map)	14
Drought severity and Additional precipitation needed to bring index near zero (maps)	15
Ground-water conditions	16
Hydrogeologic framework of the Floridan aquifer system in Florida, and in parts of Georgia, Alabama, and South Carolina	18
Temperature and precipitation outlooks for April through June 1987 (maps)	19
Explanation of data	19

LOCATION OF SITES FOR WHICH FLOOD DATA ARE GIVEN



← NEW HAMPSHIRE AND MAINE

FLORIDA



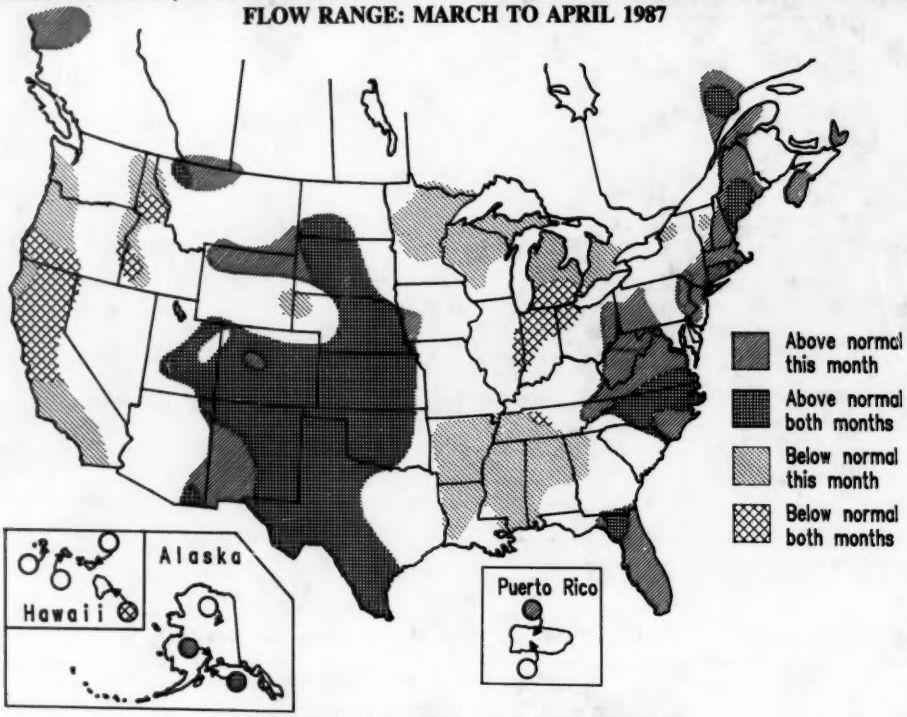
Provisional data; subject to revision

FLOOD DATA FOR SELECTED SITES IN MAINE, NEW HAMPSHIRE, AND FLORIDA, MARCH–APRIL 1987

WRD station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known			Maximum during present flood				
				Date	Stage (feet)	Discharge (cfs)	Date	Stage (feet)	Discharge		Recurrence interval (years)
									Cfs	Cfs per square mile	
	MAINE										
	PENOBSCOT RIVER BASIN										
01031500	Piscataquis River near Dover-Foxcroft	298	1902–	Nov. 4, 1966	17.89	22,800	Apr. 1	22.6	33,000	111	[a]1.30
01033000	Sebec River at Sebec	326	1924–	Mar. 20, 1936	14.46	11,400	2	12.90	12,000	37	[a]1.20
01034500	Penobscot River at West Enfield	6,671	1901–	May 1, 1923	25.15	153,000	2	23.58	145,000	22	85
01036390	Penobscot River at Eddington	7,764	1979–	June 3, 1984	20.60	136,000	3	23.60	153,000	20	<75
	SHEEPSCOT RIVER BASIN										
01038000	Sheepscot River at North Whitefield	148	1938–	Dec. 18, 1973	12.52	6,420	1	13.76	7,400	50	100
	KENNEBEC RIVER BASIN										
01047000	Carrabasset Creek near North Anson	353	1925–	Mar. 19, 1936	[b]21.17	30,800	1	25.87	41,000	116	100
01048000	Sandy River near Mercer	514	1928–	Mar. 19, 1936	16.75	38,600	1	19.27	46,000	89	[a]1.06
01049000	Sebasticook River near Pittsfield	572	1928–	Mar. 22, 1936	13.18	14,400	3	15.53	17,500	31	[a]1.27
01049265	Kennebec River at North Sidney	5,403	1978–	June 1, 1984	26.60	113,000	2	39.36	220,000	41	100
01049373	Mill Stream at Winthrop	32.7	1977–	June 2, 1984	4.76	671	2	6.16	1,250	38	25
	ANDROSCOGGIN RIVER BASIN										
01054200	Wild River at Gilead	69.6	1964–	Apr. 5, 1984	12.95	13,400	Mar. 31	13.10	19,000	273	75
01054500	Androscoggin River at Rumford	2,069	1892–	Mar. 20, 1936	. . .	74,000	Apr. 1	22.20	57,000	28	100
01055500	Nezinscot River at Turner Center	169	1941–	Mar. 27, 1953	11.18	13,900	1	10.10	11,000	65	100
01057000	Little Androscoggin River near South Paris.	73.5	1931–	Mar. 27, 1953	12.41	8,000	1	12.22	9,300	127	[a]1.42
01059000	Androscoggin River near Auburn	3,263	1928–	Mar. 20, 1936	27.57	135,000	2	23.7	102,000	31	100
	NEW HAMPSHIRE										
	SACO RIVER BASIN										
01064500	Saco River near Conway	385	1929–	Mar. 27, 1953	17.20	43,900	Apr. 3	17.07	43,000	111	50
	FLORIDA										
	KISSIMMEE RIVER BASIN										
02264100	Bonnet Creek near Vineland	56.1	1966–	June 28, 1974	[c]75.64	476	Mar. 30	74.66	500	8.9	(d)
02266200	Whittenhorse Creek near Vineland	12.4	1966–	July 27, 1984	94.78	52	31	94.81	56.2	4.5	(d)
	HILLSBOROUGH RIVER BASIN										
02303400	Cypress Creek near San Antonio	56.0	1962–	June 27–28, 1974	[c]75.23	717	31	76.05	1,050	18.8	25
02303420	Cypress Creek at Worthington Gardens	117	1964–	June 30, 1974	12.56	1,210	Apr. 3	12.62	1,440	12.3	10

[a]Approximate ratio of discharge to that of 100-year flood.
[b]Maximum gage height 27.78 feet, Feb. 21, 1978 (ice jam).
[c]Maximum gage height 78.58 feet, Nov. 1, 1969.
[d]Not determined.
[e]Maximum gage height 75.70 feet, Sept. 13, 1964.

PERSISTENCE IN, OR MOVEMENT INTO, THE BELOW-NORMAL OR ABOVE-NORMAL FLOW RANGE: MARCH TO APRIL 1987



SUMMARY OF APRIL 1987 STREAMFLOW

[Flow ranges]

Area	Below normal range		Normal range		Above normal range		Number of stations	
	No.	Percent	No.	Percent	No.	Percent	Reporting data	Missing data
Conterminous United States.	43	26.7	54	33.5	64	39.8	161	*2
Alaska, Hawaii, and Puerto Rico.	1	10.0	6	60.0	3	30.0	10	0
United States and Puerto Rico.	44	25.7	60	35.1	67	39.2	171	*2
Southern Canada.....	1	5.6	12	66.7	5	27.8	18	0
Conterminous United States and southern Canada.	44	24.6	66	36.9	69	38.5	179	*2
All sites.....	45	23.8	72	38.1	72	38.1	189	*2

*Rio Grande below Taos Junction Bridge near Taos, New Mexico, and Pecos River near Pecos, New Mexico.

[Comparison of total monthly means with total monthly medians and last month's total monthly means]

Total of April means (*188 sites).....	3,142,230 CFS
Total of April medians (*188 sites).....	2,975,280 CFS
Total of last month's means (*188 sites).....	2,814,560 CFS
Total of April means compared to total of medians.....	+5.6 Percent
Total of April means compared to total of last month's means.....	+11.2 Percent

*Qu'Apelle River at Lumsden, Saskatchewan, Canada–no March data.

NEW EXTREMES DURING APRIL 1987 AT STREAMFLOW INDEX STATIONS

Station number	Stream and place of determination	Drainage area (square miles)	Years of record	Previous April extremes (period of record)		April 1987			
				Monthly mean in cfs (year)	Daily mean in cfs (year)	Monthly mean in cfs	Percent of median	Daily mean in cfs	Day
				HIGHS					
01204000	Pomperaug River at Southbury, Conn.	75.0	54	556 (1983)	2,160 (1980)	630	259	3,860	5
02045500	Nottaway River near Stony Creek, Va.	579	57	2,021 (1978)	12,300 (1978)	2,260	297	12,700	19
03183500	Greenbrier River at Alderson, W. Va.	1,357	91	6,414 (1901)	47,000 (1977)	7,349	246	27,400	17
03193000	Kanawha River at Kanawha Falls, W. Va.	8,367	109	46,930 (1901)	201,000 (1901)	50,440	301	96,400	25
03488000	North Fork Holston River near Saltville, Va.	222	67	1,046 (1977)	10,900 (1977)	1,307	300	4,230	17
06867000	Saline River near Russell, Kans.	1,502	35	604 (1973)	3,750 (1973)	893	1,912	4,940	14
06884400	Little Blue River near Barnes, Kans.	3,324	28	2,730 (1984)	9,400 (1986)	3,840	934	15,800	16
02TE001	Outardes River at Outardes Falls, Quebec, Canada	7,300	64	18,600 (1979)	43,600 (1979)	21,700	400	. . .	. .
50038100	Rio Grande De Manati at Highway 2 near Manati, Puerto Rico	197	16	752 (1978)	12,200 (1983)	866	220	8,600	12
				LOWS					
05365500	Chippewa River at Chippewa Falls, Wis.	5,650	98	3,253 (1931)	150 (1934)	2,639	25	900	18

for last April but higher than those for last month, except for the level of Lake Superior, which declined from last month's mean. Levels of all four lakes remained above median. Stage hydrographs for Lakes Superior, Huron, Erie, and Ontario are on page 6.

The level of Utah's Great Salt Lake fell 0.15 foot during April, reaching 4,211.70 feet above NGVD of 1929 on April 30, after equalling last year's record high just one month ago. The graph of lake level from February 1, 1981, to April 31, 1987 (page 6), clearly shows that the decline is earliest in recent years. If this decline, which began April 6, is the seasonal decline for 1987, it will be one of the earliest recorded since 1888. Only eight seasonal declines beginning this early have been recorded. Lake level normally peaks in May or June, but since the snowpack is virtually gone, only cooler and wetter weather than normal would reverse the decline. The West Desert Pumping Project began operation during the month with the first pump starting up on April 15.

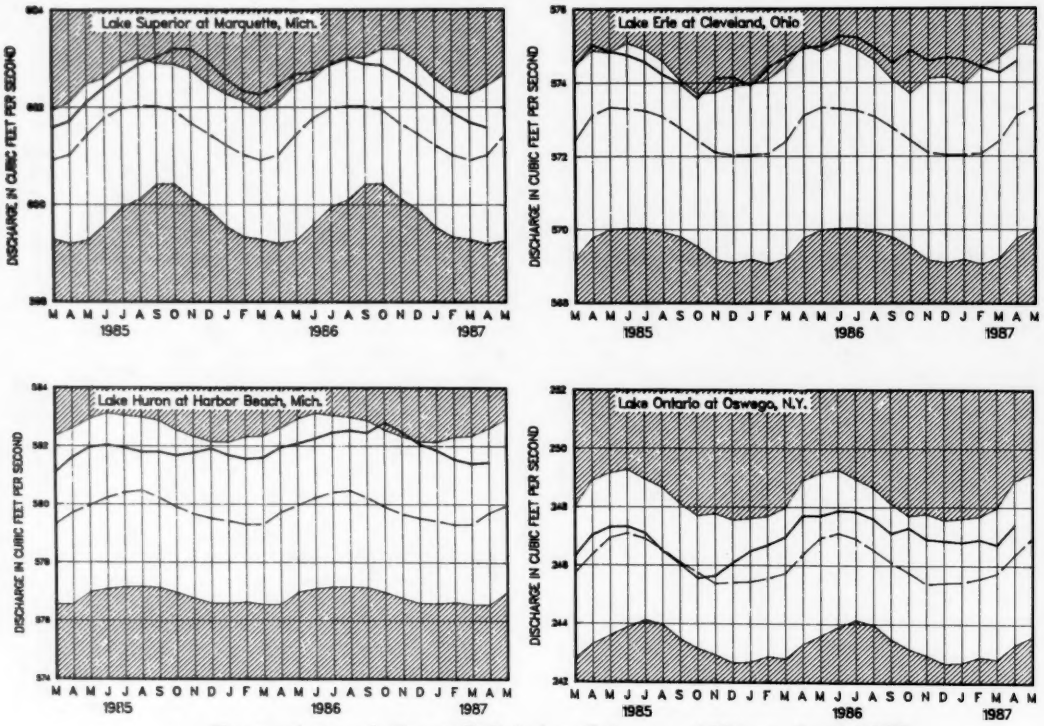
April precipitation (see maps on page 7) was generally an inch or more below average over most of the upper Missouri River basin, and also in the Great Plains, Great Lakes, and Southeastern States, according to provisional NWS data. Precipitation was generally an inch or more above average in the area from southern Maine to New Jersey and extending inland through Pennsylvania, and also in an area centered on the Virginia-North Carolina border. Total precipitation exceeded 6 inches in 16 cities during the month, 14 of them in New England, West Virginia, Virginia, and North Carolina. Those cities with more than 6 inches of precipitation which also had record-high amounts for April are: Roanoke, Virginia, 11.35 inches; Boston, Massachusetts, 9.46 inches; Greensboro, North Carolina, 8.03 inches; Beckley, West Virginia, 7.63 inches; Richmond, Virginia, 7.31 inches. May through July outlook maps for both temperature and precipitation are shown on page 19.

Contents of 89 percent of reporting reservoirs were near or above average for the end of April, compared with 87 percent for the end of March. Most reporting reservoirs in New England, New Jersey, North Carolina, the Tennessee Valley, Texas, Colorado, Wyoming, Arizona, and California had contents significantly above average for the end of April. The only reservoirs with both significant declines in contents during the month and significantly below-average contents for the end of the month were Keystone in Oklahoma, and Possum Kingdom in Texas. Graphs of contents for seven reservoirs are shown on page 8 with contents for the 97 reporting reservoirs given on page 9.

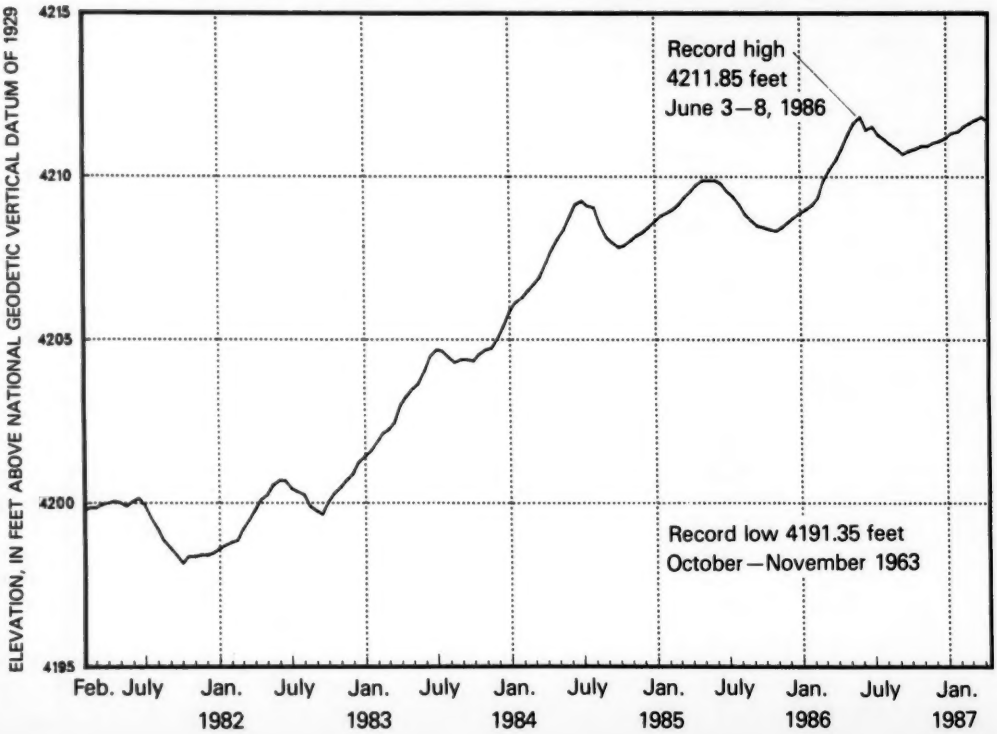
The combined flow of the 3 largest rivers in the lower 48 States—Mississippi, St. Lawrence, and Columbia—averaged 1,396,900 cfs during April, 0.2 percent below median, and 3.1 percent below last month's flow. Flow hydrographs for both the combined and individual flows of the "Big 3" are shown on page 10. April flows of these three rivers are given in the Flow of Large Rivers table on page 11. Dissolved solids and water temperatures at five large river stations are given on page 10.

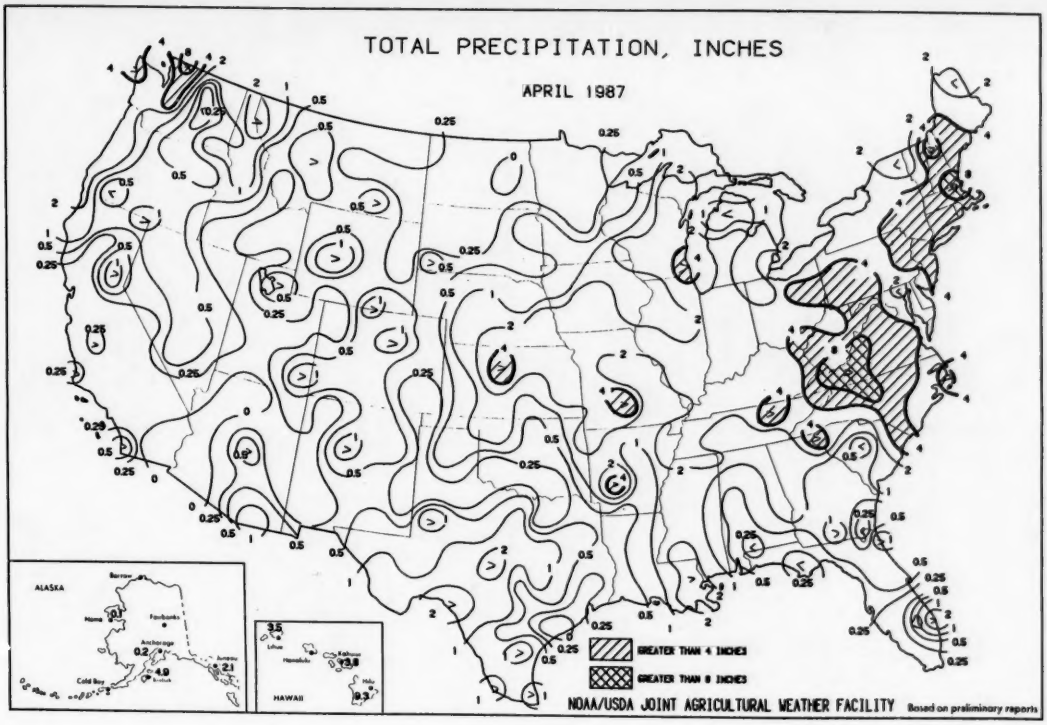
GREAT LAKES ELEVATIONS

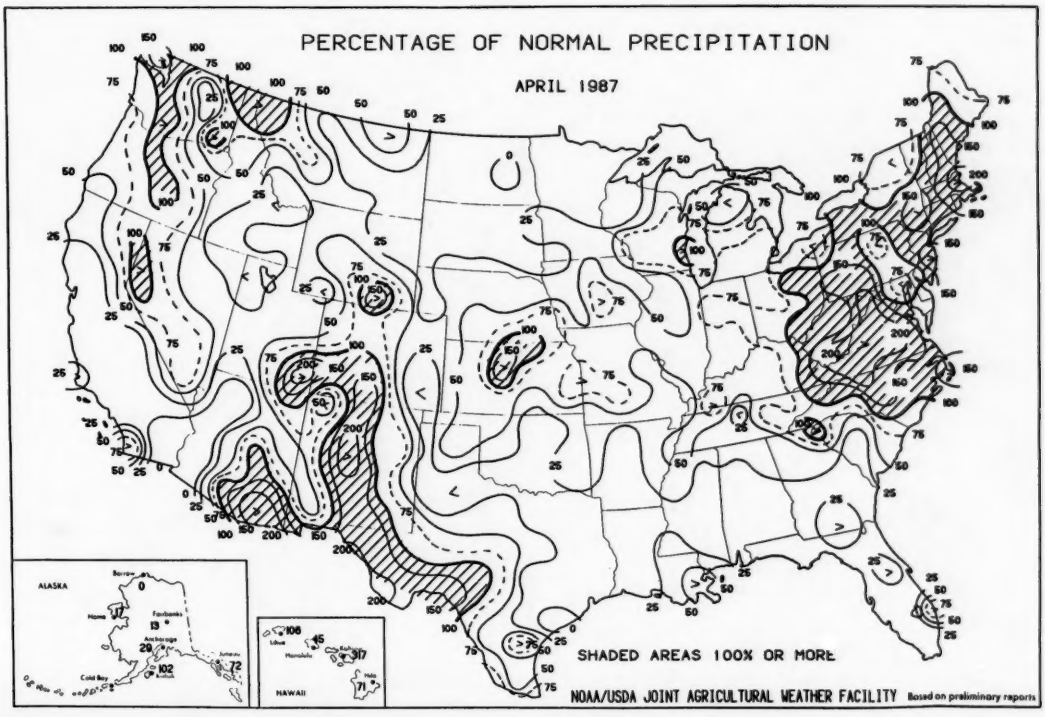
Unshaded area indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951–80. Heavy line indicates mean for current period. Data from National Ocean Service.


Lake Superior at Marquette, Mich.
Lake Erie at Cleveland, Ohio
Lake Huron at Harbor Beach, Mich.
Lake Ontario at Oswego, N.Y.
DISCHARGE IN CUBIC FEET PER SECOND
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M
1985
1986
1987

Fluctuations of Great Salt Lake, February 1981 to April 1987

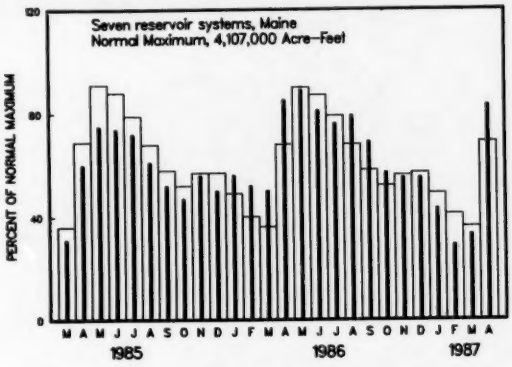


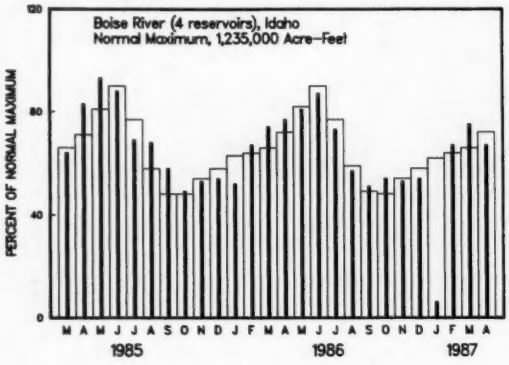


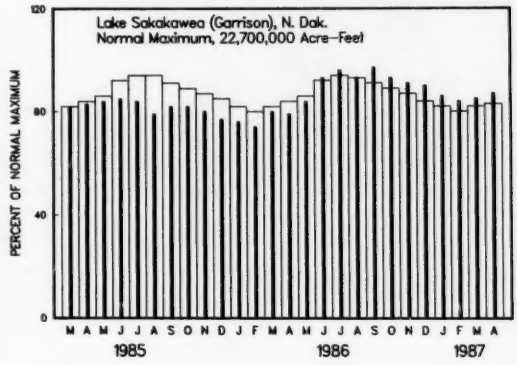


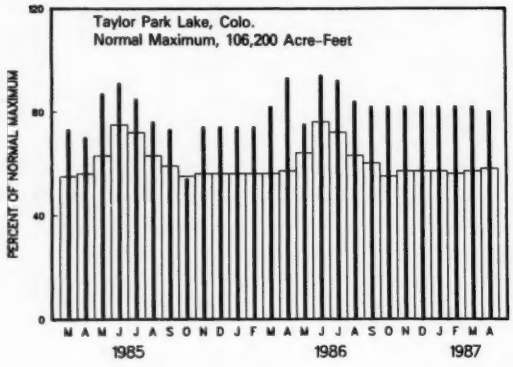
(From *Weekly Weather and Crop Bulletin* prepared and published by the NOAA/USDA Joint Agricultural Weather Facility)

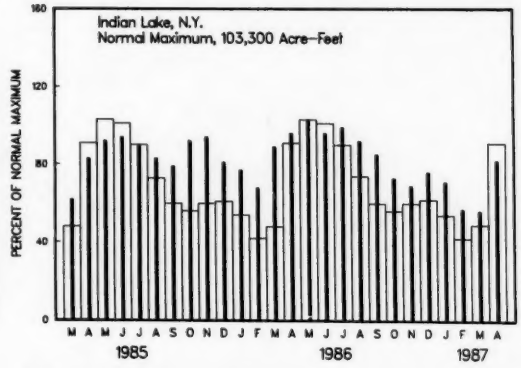
USABLE CONTENTS OF SELECTED RESERVOIRS AND RESERVOIR SYSTEMS

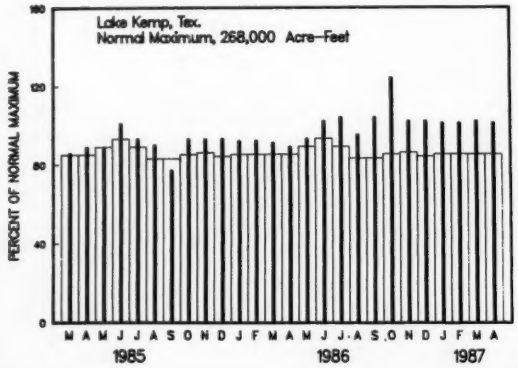

Seven reservoir systems, Maine
Normal Maximum, 4,107,000 Acre-Feet
PERCENT OF NORMAL MAXIMUM
0
40
80
120
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A
1985
1986
1987

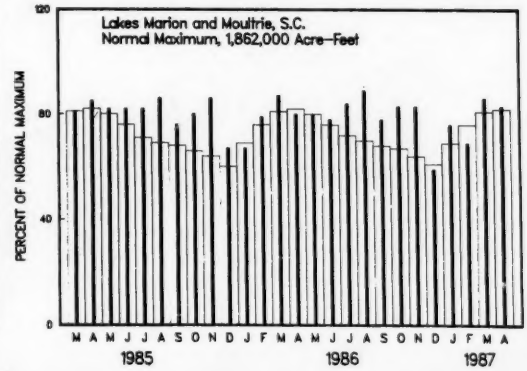

Boise River (4 reservoirs), Idaho
Normal Maximum, 1,235,000 Acre-Feet
PERCENT OF NORMAL MAXIMUM
0
40
80
120
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A
1985
1986
1987


Lake Sakakawea (Garrison), N. Dak.
Normal Maximum, 22,700,000 Acre-Feet
PERCENT OF NORMAL MAXIMUM
0
40
80
120
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A
1985
1986
1987


Taylor Park Lake, Colo.
Normal Maximum, 106,200 Acre-Feet
PERCENT OF NORMAL MAXIMUM
0
40
80
120
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A
1985
1986
1987


Indian Lake, N.Y.
Normal Maximum, 103,300 Acre-Feet
PERCENT OF NORMAL MAXIMUM
0
40
80
120
160
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A
1985
1986
1987


Lake Kemp, Tex.
Normal Maximum, 268,000 Acre-Feet
PERCENT OF NORMAL MAXIMUM
0
40
80
120
160
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A
1985
1986
1987


Lakes Marion and Moultrie, S.C.
Normal Maximum, 1,862,000 Acre-Feet
PERCENT OF NORMAL MAXIMUM
0
40
80
120
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A
1985
1986
1987

USABLE CONTENTS OF SELECTED RESERVOIRS NEAR END OF APRIL 1987

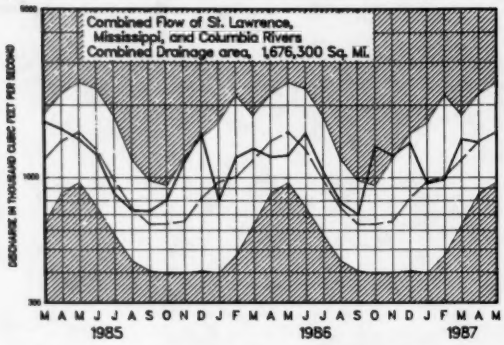
[Contents are expressed in percent of reservoir capacity. The usable storage capacity of each reservoir is shown in the column headed "Normal maximum."]

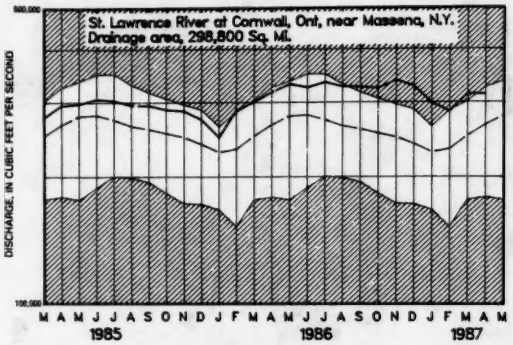
Reservoir Principal uses: F–Flood control I–Irrigation M–Municipal P–Power R–Recreation W–Industrial	Percent of normal maximum				Normal maximum[a] (acre-feet)
	End of Apr. 1987	End of Apr. 1986	Average for end of Apr.	End of Mar. 1987	
NOVA SCOTIA					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs(P)	48	56	77	22	[b]226,300
QUEBEC					
Allard (P)	85	76	80	11	280,600
Gouin (P)	67	57	51	68	6,954,000
MAINE					
Seven reservoir systems (MP)	83	85	69	33	4,107,000
NEW HAMPSHIRE					
First Connecticut Lake (P)	75	67	51	27	76,450
Lake Francis (FPR)	62	62	56	28	99,310
Lake Winnipesaukee (PR)	97	94	97	61	165,700
VERMONT					
Harriman (P)	86	86	78	33	116,200
Somerset (P)	86	80	75	42	57,390
MASSACHUSETTS					
Cobble Mountain and Borden Brook (MP)	96	84	88	84	77,920
NEW YORK					
Great Sacandaga Lake (FPR)	90	90	91	48	786,700
Indian Lake (FMP)	82	96	91	56	103,300
New York City reservoir system (MW)	99	99	100	95	1,680,000
NEW JERSEY					
Wanaque (M)	101	101	93	100	85,100
PENNSYLVANIA					
Allegheny (FPR)	50	52	45	40	1,180,000
Pymatuning (FMR)	94	96	102	80	188,000
Raystown Lake (FR)	68	68	59	68	761,900
Lake Wallenpaupack (PR)	76	81	79	59	157,800
MARYLAND					
Baltimore municipal system (M)	87	86	94	81	261,900
NORTH CAROLINA					
Bridgewater (Lake James) (P)	100	90	93	95	288,800
Narrows (Badin Lake) (P)	100	90	100	93	128,900
High Rock Lake (P)	100	67	84	93	234,800
SOUTH CAROLINA					
Lake Murray (P)	92	89	83	93	1,614,000
Lakes Marion and Moultrie (P)	83	80	82	86	1,862,000
SOUTH CAROLINA—GEORGIA					
Clark Hill (FP)	78	57	75	77	1,730,000
GEORGIA					
Burton (PR)	97	92	90	89	104,000
Sinclair (MPR)	88	89	91	99	214,000
Lake Sidney Lanier (FMPR)	65	50	63	63	1,686,000
ALABAMA					
Lake Martin (P)	98	92	95	93	1,375,000
TENNESSEE VALLEY					
Clinch Projects: Norris and Melton Hill Lakes (FPR)	75	51	61	53	2,293,000
Douglas Lake (FPR)	76	36	61	35	1,394,000
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR)	73	60	77	62	1,012,000
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	87	58	66	64	2,880,000
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	75	52	76	62	1,478,000
WISCONSIN					
Chippewa and Flambeau (PR)	75	94	72	68	365,000
Wisconsin River (21 reservoirs) (PR)	50	87	71	34	399,000
MINNESOTA					
Mississippi River headwater system (FMR)	33	44	31	30	1,640,000
NORTH DAKOTA					
Lake Sakakawea (Garrison) (FIPR)	87	79	83	85	22,700,000
SOUTH DAKOTA					
Angostura (I)	95	92	85	95	127,600
Belle Fourche (I)	96	62	71	87	185,200
Lake Francis Case (FIP)	81	86	82	88	4,834,000
Lake Oahe (FIP)	95	97	. . .	91	22,530,000
Lake Sharpe (FIP)	100	101	100	100	1,725,000
Lewis and Clark Lake (FIP)	74	77	81	78	432,000
NEBRASKA					
Lake McConaughy (IP)	82	84	79	81	1,948,000
OKLAHOMA					
Eufaula (FRP)	97	99	95	110	2,378,000
Keystone (FPR)	86	85	105	105	661,000
Tenkiller Ferry (FPR)	104	109	99	113	628,200
Lake Altus (FIMR)	100	30	55	100	133,000
Lake O'The Cherokees (FPR)	94	96	92	103	1,492,000
OKLAHOMA—TEXAS					
Lake Texoma (FMPRW)	97	96	92	101	2,722,000
TEXAS					
Bridgeport (IMW)	100	79	52	100	386,400
Canyon (FMR)	99	96	80	103	385,600
International Amistad (FIMPW)	87	54	81	85	3,497,000
International Falcon (FIMPW)	85	24	67	86	2,668,000
Livingston (IMW)	100	101	90	104	1,788,000
Possum Kingdom (IMPRW)	67	86	95	97	570,200
Red Bluff (PI)	89	21	25	91	307,000
Toledo Bend (P)	91	93	90	98	4,472,000
Twin Buttes (FIM)	68	11	30	62	177,800
Lake Kemp (IMW)	101	89	85	102	268,000
Lake Meredith (FWM)	30	29	36	29	796,900
Lake Travis (FIMPRW)	98	93	81	99	1,144,000
MONTANA					
Canyon Ferry (FIMPR)	77	75	74	77	2,043,000
Fort Peck (FPR)	85	76	83	84	18,910,000
Hungry Horse (FIPR)	77	79	57	68	3,451,000
WASHINGTON					
Ross (PR)	30	51	28	19	1,052,000
Franklin D. Roosevelt Lake (IP)	89	55	46	94	5,022,000
Lake Chelan (PR)	30	57	39	19	676,100
Lake Cushman (PR)	84	98	88	78	359,500
Lake Merwin (P)	103	103	101	100	245,600
IDAHO					
Boise River (4 reservoirs) (FIP)	67	77	72	75	1,235,000
Coeur d'Alene Lake (P)	87	70	124	59	238,500
Pend Oreille Lake (FP)	56	51	57	51	1,561,000
IDAHO—WYOMING					
Upper Snake River (8 reservoirs) (MP)	71	59	74	79	4,401,000
WYOMING					
Boysen (FIP)	72	62	60	72	802,000
Buffalo Bill (IP)	68	70	61	65	421,300
Keyhole (F)	45	35	47	44	193,800
Pathfinder, Seminoe, Alcova, Kortes, Glendo, and Guernsey Reservoirs (I)	79	72	55	75	3,056,000
COLORADO					
John Martin (FIR)	97	71	18	97	364,400
Taylor Park (IR)	51	46	54	62	106,200
Colorado–Big Thompson project (I)	80	93	58	82	730,300
COLORADO RIVER STORAGE PROJECT					
Lake Powell; Flaming Gorge, Fontenelle, Navajo, and Blue Mesa Reservoirs (IFPR)	100	85	. . .	83	31,620,000
UTAH—IDAHO					
Bear Lake (IPR)	79	86	65	79	1,421,000
CALIFORNIA					
Folsom (FIP)	71	69	74	65	1,000,000
Hetch Hetchy (MP)	44	71	39	34	360,400
Isabella (FIR)	43	79	36	42	568,100
Pine Flat (FI)	72	73	63	61	1,001,000
Clair Engle Lake (Lewiston) (P)	90	92	87	85	2,438,000
Lake Almanor (P)	88	100	61	83	1,036,000
Lake Berryessa (FIMW)	86	100	90	87	1,600,000
Millerton Lake (FI)	48	42	67	40	503,200
Shasta Lake (FIPR)	93	93	91	94	4,377,000
CALIFORNIA—NEVADA					
Lake Tahoe (IPR)	69	88	60	67	744,600
NEVADA					
Rye Patch (I)	71	94	74	84	194,300
ARIZONA—NEVADA					
Lake Mead and Lake Mohave (FIMP)	92	90	68	93	27,970,000
ARIZONA					
San Carlos (IP)	85	95	30	84	935,100
Salt and Verde River system (IMPR)	99	98	56	101	2,019,100
NEW MEXICO					
Conchas (FIR)	. .	81	77	100	330,100
Elephant Butte and Caballo (FIPR)	. .	95	31	95	2,442,000

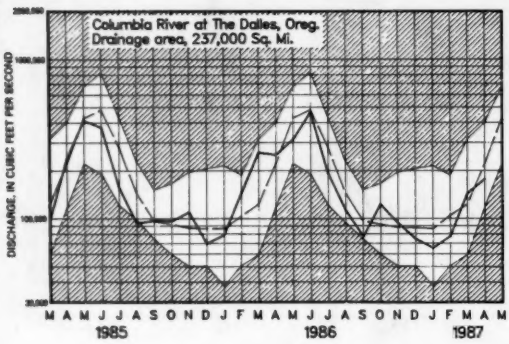
[a] 1 acre-foot = 0.04356 million cubic feet = 0.326 million gallons = 0.504 cubic feet per second day.
[b] Thousands of kilowatt-hours (the potential electric power that could be generated by the volume of water in storage).

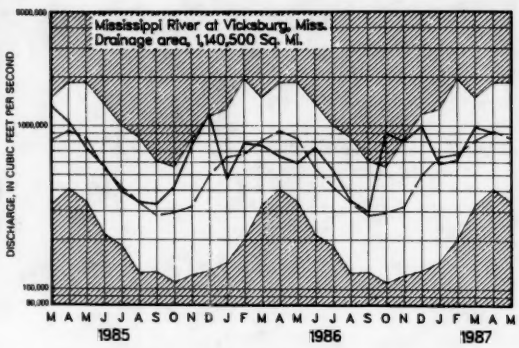
HYDROGRAPHS FOR THE "BIG THREE" RIVERS

Unshaded area indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951–80. Heavy line indicates mean for current period.


Combined Flow of St. Lawrence, Mississippi, and Columbia Rivers
Combined Drainage area, 1,676,300 Sq. Mi.
DISCHARGE IN THOUSAND CUBIC FEET PER SECOND
M A M J J A S O N D J F M A M J J A S O N D J F M A M
1985
1986
1987


St. Lawrence River at Cornwall, Ont, near Massena, N.Y.
Drainage area, 298,800 Sq. Mi.
DISCHARGE, IN CUBIC FEET PER SECOND
M A M J J A S O N D J F M A M J J A S O N D J F M A M
1985
1986
1987


Columbia River at The Dalles, Oreg.
Drainage area, 237,000 Sq. Mi.
DISCHARGE, IN CUBIC FEET PER SECOND
M A M J J A S O N D J F M A M J J A S O N D J F M A M
1985
1986
1987


Mississippi River at Vicksburg, Miss.
Drainage area, 1,140,500 Sq. Mi.
DISCHARGE, IN CUBIC FEET PER SECOND
M A M J J A S O N D J F M A M J J A S O N D J F M A M
1985
1986
1987

Provisional data; subject to revision

DISSOLVED SOLIDS AND WATER TEMPERATURES, FOR APRIL 1987, AT DOWNSTREAM SITES ON FIVE LARGE RIVERS

Station number	Station name	April data of following calendar years	Stream discharge during month	Dissolved-solids concentration[a]		Dissolved-solids discharge[a]			Water temperature[b]		
			Mean (cfs)	Minimum (mg/L)	Maximum (mg/L)	Mean	Minimum	Maximum	Mean in °C	Minimum, in °C	Maximum, in °C
						(tons per day)					
01463500	Delaware River at Trenton, N.J. (Morrisville, Pa.).	1987	29,500	65	102	6,040	2,895	14,620	11.5	7.5	16.0
		1945–86	22,040	46	124	....	1,200	21,500	...	3.0	22.5
		(Extreme yr)		(1962)	(1981)		(1985)	(1983)			
			[c]22,320								
07289000	Mississippi River at Vicksburg, MS.	1987	906,800	213	261	581,300	483,200	766,600	14.0	12.0	20.0
		1976–86	1,007,600	150	288	555,800	180,000	1,030,000	15.5	7.0	22.5
		(Extreme yr)		(1985)	(1986)		(1981)	(1979)			
			[c]930,400								
03612500	Ohio River at lock and dam 53, near Grand Chain, IL (streamflow station at Metropolis, IL).	1987	418,000	160	242	....	148,000	273,000	...	9.0	14.0
		1955–86	437,000	117	282	....	22,400	462,000	...	6.5	19.0
		(Extreme yr)		(1957)	(1969)		(1976)	(1975)			
			[c]480,500								
06934500	Missouri River at Hermann, MO (60 miles west of St. Louis, MO).	1987	177,000	321	418	173,000	129,000	243,000	14.0	11.5	16.0
		1976–86	131,500	157	504	113,500	41,400	270,000	13.5	6.0	22.5
		(Extreme yr)		(1979)	(1981)		(1977)	(1984)			
			[c]88,120								
14128910	Columbia River at Warrendale, OR (streamflow station at The Dalles, OR).	1987	142,000	98	122	41,300	35,500	52,500	9.5	8.0	11.5
		1976–86	210,700	85	128	59,700	22,300	96,100	9.0	6.5	12.5
		(Extreme yr)		(1976)	(1985)		(1977	(1984)			
			[c]220,700								

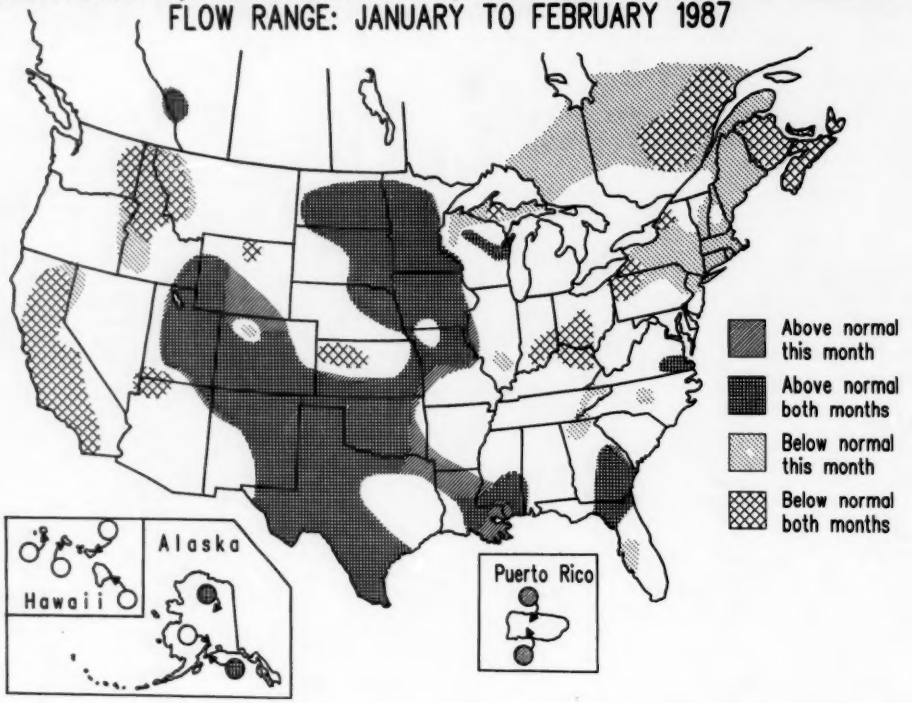
[a]Dissolved-solids concentrations, when not analyzed directly, are calculated on basis of measurements of specific conductance.
[b]To convert °C to °F: [(1.8 X °C) + 32] = °F.
[c]Median of monthly values for 30-year reference period, water years 1951–80, for comparison with data for current month.

FLOW OF LARGE RIVERS DURING APRIL 1987

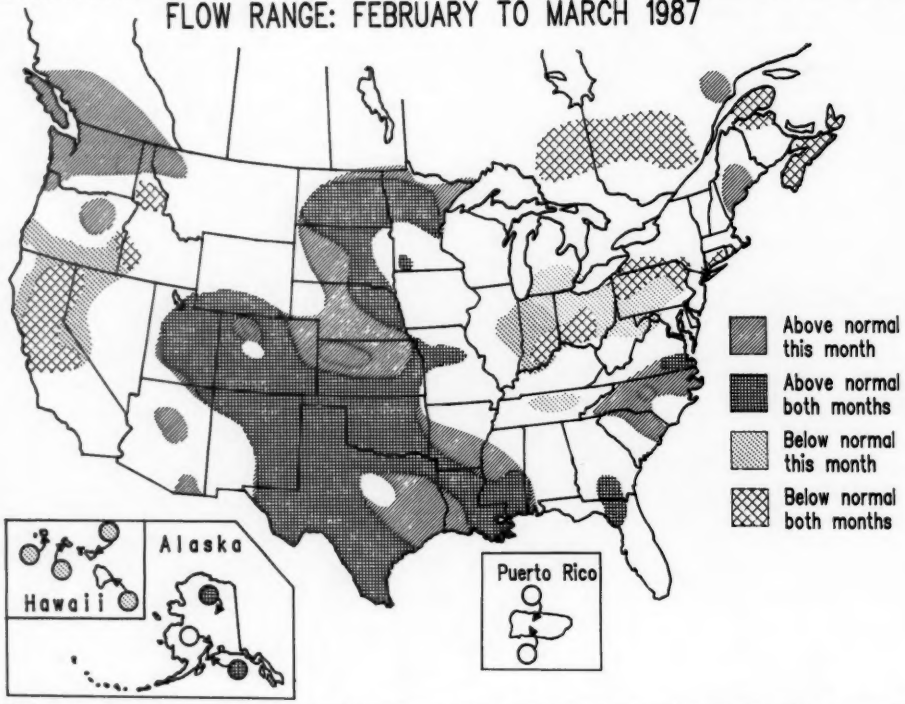
Station number	Stream and place of determination	Drainage area (square miles)	Average discharge through September 1980 (cubic feet per second)	April 1987					
				Monthly mean discharge (cubic feet per second)	Percent of median monthly discharge, 1951—80	Change in discharge from previous month (percent)	Discharge near end of month		
							Cubic feet per second	Million gallons per day	Date
01014000	St. John River below Fish River at Fort Kent, Maine	5,690	9,647	41,440	197	+1,158	10,900	7,040	30
01318500	Hudson River at Hadley, N.Y.	1,664	2,909	9,020	100	+156	2,570	1,661	30
01357500	Mohawk River at Cohoes, N.Y.	3,456	5,734	17,000	124	+50	2,200	1,420	30
01463500	Delaware River at Trenton, N.J.	6,780	11,750	29,500	127	+88	10,500	6,790	30
01570500	Susquehanna River at Harrisburg, Pa.	24,100	34,530	80,680	111	+61	32,100	20,750	30
01646500	Potomac River near Washington, D.C.	11,560	[1]11,490	[1]46,300	247	+176	24,500	15,830	30
02105500	Cape Fear River at William O. Huske Lock near Tarheel, N.C.	4,810	5,005	10,000	161	+25	8,000	5,200	30
02131000	Pee Dee River at Peedee, S.C.	8,830	9,851	21,300	158	−35	31,800	20,550	30
02226000	Altamaha River at Doctortown, Ga.	13,600	13,880	24,730	104	−37	11,000	7,100	28
02320500	Suwannee River at Branford, Fl.	7,880	6,987	19,500	193	−23	11,800	7,630	30
02358000	Apalachicola River at Chattahoochee, Fl.	17,200	22,570	27,600	83	−40	17,700	11,440	30
02467000	Tombigbee River at Demopolis lock and dam near Coatopa, Ala.	15,400	23,300	14,240	30	−79	5,750	3,716	30
02489500	Pearl River near Bogalusa, La.	6,630	9,768	6,974	40	−84	3,820	2,468	30
03049500	Allegheny River at Natrona, Pa.	11,410	[1]19,480	[1]43,580	120	+107	28,470	18,400	30
03085000	Monongahela River at Braddock, Pa.	7,337	[1]12,510	[1]30,200	156	+208	25,900	16,740	28
03193000	Kanawha River at Kanawha Falls, W.Va.	8,367	12,590	50,440	301	+71	65,300	42,200	29
03234500	Scioto River at Higby, Ohio.	5,131	4,547	7,883	106	+323	2,010	1,299	30
03294500	Ohio River at Louisville, Ky.[2]	91,170	11,600	320,100	153	+105	412,700	266,700	30
03377500	Wabash River at Mount Carmel, Ill.	28,635	27,220	27,970	56	+19	17,300	11,180	30
03469000	French Broad River below Douglas Dam, Tenn.	4,543	6,798	14,230	127	+16	. . .	. . .	. .
04084500	Fox River at Rapide Croche Dam, near Wrightstown, Wis.[2]	6,150	4,163	4,453	64	+15	7,877	5,091	30
04264331	St. Lawrence River at Cornwall, Ontario–near Massena, N.Y.[3]	298,800	242,700	313,000	118	0	340,000	220,000	30
02NG001	St. Maurice River at Grand Mere, Quebec	16,300	25,150	50,000	114	+753	17,100	11,050	30
05082500	Red River of the North at Grand Forks, N.Dak.	30,100	2,551	7,575	86	−7	4,020	2,598	27
05133500	Rainy River at Manitou Rapids, Minn.	19,400	11,830	9,170	55	+2	6,030	3,897	29
05330000	Minnesota River near Jordan, Minn.	16,200	3,402	6,522	92	+79	4,680	3,024	30
05331000	Mississippi River at St. Paul, Minn.	36,800	[1]10,610	15,830	64	+27	11,100	7,170	30
05365500	Chippewa River at Chippewa Falls, Wis.	5,600	5,100	2,639	25	−35	2,600	1,680	30
05407000	Wisconsin River at Muscoda, Wis.	10,300	8,617	7,733	49	−13	9,082	5,869	30
05446500	Rock River near Joslin, Ill.	9,551	5,873	7,840	78	+22	9,500	6,140	30
05474500	Mississippi River at Keokuk, Iowa.	119,000	62,620	80,700	63	+17	74,900	48,410	30
06214500	Yellowstone River at Billings, Mont.	11,796	7,038	3,730	94	+40	9,000	5,800	30
06934500	Missouri River at Hermann, Mo.	524,200	79,490	178,700	203	+22	125,000	80,800	30
07289000	Mississippi River at Vicksburg, Miss.[4]	1,140,500	576,600	906,800	97	−8	1,100,000	710,000	27
07331000	Washita River near Dickson, Okla.	7,202	1,368	3,590	384	−66	1,500	970	30
08276500	Rio Grande below Taos Junction Bridge, near Taos, N.Mex.	9,730	725	. . .	. . .	. . .	. . .	. . .	. .
09315000	Green River at Green River, Utah.	44,850	6,298	6,348	119	+20	8,940	5,780	24
11425500	Sacramento River at Verona, Calif.	21,257	18,820	10,470	53	−48	10,820	6,993	28
13269000	Snake River at Weiser, Idaho.	69,200	18,050	10,600	48	−23	10,800	6,980	30
13317000	Salmon River at White Bird, Idaho.	13,550	11,250	10,300	100	+102	25,000	16,200	30
13342500	Clearwater River at Spalding, Idaho.	9,570	15,480	15,600	54	+78	44,760	28,930	30
14105700	Columbia River at The Dalles, Oreg.[5]	237,000	[1]193,100	[1]177,100	80	+24	135,900	87,830	27
14191000	Willamette River at Salem, Oreg.	7,280	[1]23,510	[1]16,500	57	−41	9,550	6,172	27
15515500	Tanana River at Nenana, Alaska.	25,600	23,460	7,703	96	+14	12,200	7,890	30
08MF005	Fraser River at Hope, British Columbia.	83,800	96,290	78,390	131	+72	94,280	60,930	30

[1]Adjusted.
[2]Records furnished by Corps of Engineers.
[3]Records furnished by Buffalo District, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y. when adjusted for storage in Lake St. Lawrence.
[4]Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.
[5]Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.

PERSISTENCE IN, OR MOVEMENT INTO, THE BELOW-NORMAL OR ABOVE-NORMAL FLOW RANGE: JANUARY TO FEBRUARY 1987



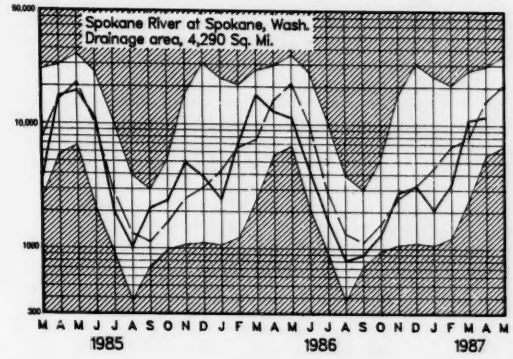
PERSISTENCE IN, OR MOVEMENT INTO, THE BELOW-NORMAL OR ABOVE-NORMAL FLOW RANGE: FEBRUARY TO MARCH 1987

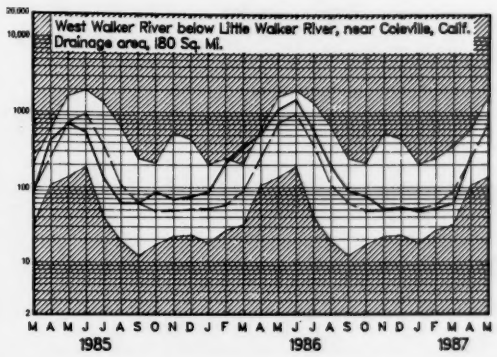


Editor's Note: These maps are the correct persistence/change maps for the months indicated. Previously-published maps for these months were either incorrect or mislabeled.

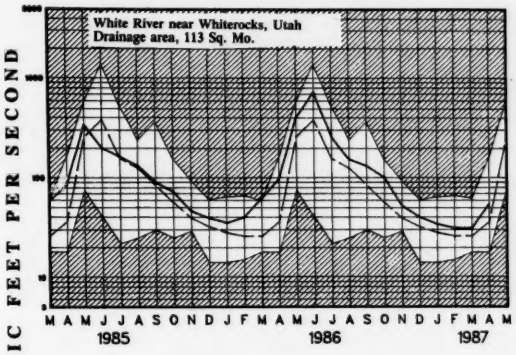
MONTHLY MEAN DISCHARGE OF SELECTED STREAMS

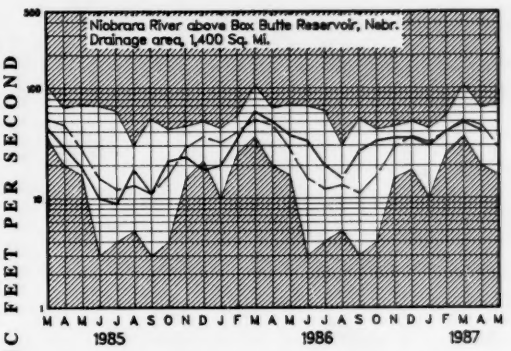
Unshaded area indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951–80. Heavy line indicates mean for current period.



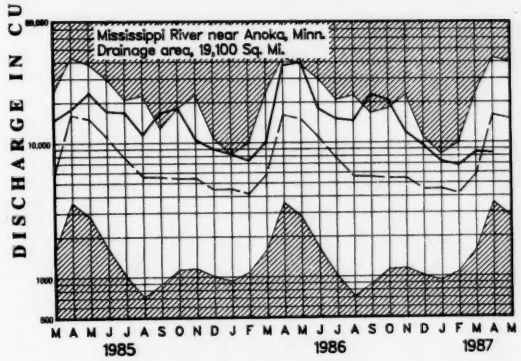

West Walker River below Little Walker River, near Coleville, Calif.
Drainage area, 180 Sq. Mi.
M A M J J A S O N D J F M A M J J A S O N D J F M A M
1985
1986
1987

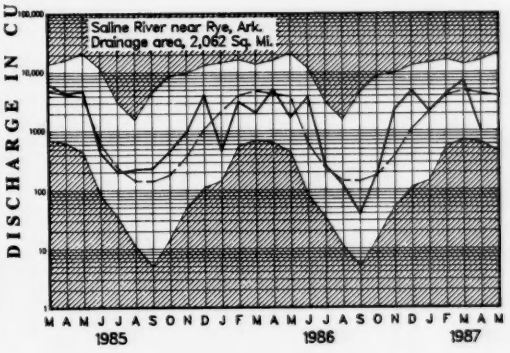
DISCHARGE IN CUBIC FEET PER SECOND

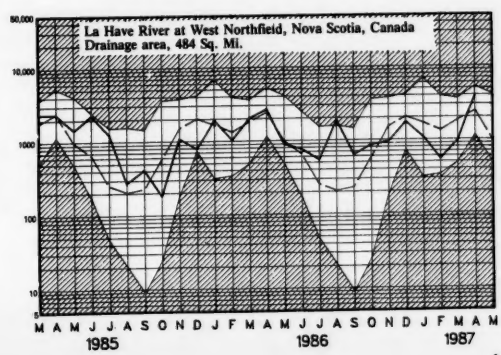


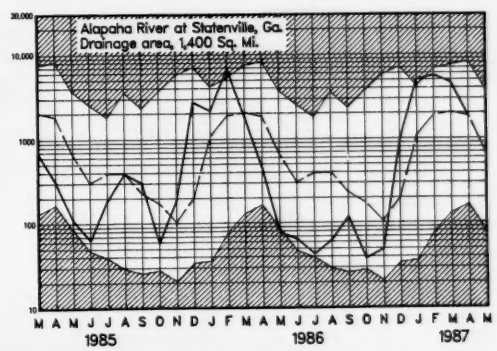


DISCHARGE IN CUBIC FEET PER SECOND






La Have River at West Northfield, Nova Scotia, Canada
Drainage area, 484 Sq. Mi.
M A M J J A S O N D J F M A M J J A S O N D J F M A M
1985
1986
1987



The Drought Severity (Long-Term, Palmer) Index

Lyle M. Denny and Thomas R. Heddinghaus

The Drought Severity, or Palmer, Index is an index of meteorological drought (or moisture excess) and indicates prolonged abnormal conditions affecting water-sensitive economics. The index usually ranges from about −6 to +6, with negative values denoting dry spells and positive values, wet spells of weather (categories of values are given under the accompanying map). The equations for the index were derived from monthly average data and based on the concept of a balance between moisture supply and demand (Palmer, 1965). The equations have been modified to compute the index on a weekly basis for publication in the Bulletin. Input data consists of weekly temperature averages and precipitation totals for 350 climate divisions in the United States and Puerto Rico.

The index is a sum of the current moisture anomaly and a portion of the previous index to include the effect of the duration of the drought or wet spell. The moisture anomaly is the product of a climate weighting factor and the moisture departure. The weighting factor allows the index to have a reasonably comparable significance for different locations and time of year. An index value for a division in Florida would have the same local implication as a similar value in a more arid division in western Kansas. The moisture departure is the difference of water supply and demand. Supply is precipitation and stored soil moisture, and demand is the potential evapotranspiration, the amount needed to recharge the soil, and runoff needed to keep the rivers, lakes, and reservoirs at a normal level. The runoff and soil recharge and loss are computed by keeping a hydrologic accounting of moisture storage in two soil layers. The surface layer can store one inch, while the available capacity in the underlying layer depends on the soil characteristics of the division being measured. Potential evapotranspiration is derived from Thornthwaite's method (1948).

The index is measured from the start of a wet or dry spell and is sometimes ambiguous until a weather spell is established. A week of normal or better rainfall is welcome in an area that has experienced a long drought, but may be only a brief respite and not the end of the drought. Once the weather spell is established (by computing a 100 percent "probability" that an opposite spell has ended), the final value is assigned. To make the program have a real-time significance, a value is assigned based on a greater than 50 percent "probability" that the opposite weather spell has ended. This is not entirely satisfactory, but it does allow the index to have a value when there is a doubt that it should be positive or negative.

One aspect that should be noted is that the demand part of the computations includes three parameters—potential evapotranspiration, recharge of soil moisture, and runoff—any one of which may produce negative values. If only enough rain fell to satisfy the expected evapotranspiration but not enough to supply the recharge and runoff, then a negative index would result. If such an odd situation continued, agriculture would progress at a normal pace but a worsening drought would be indicated. Shallow wells and springs would dry and the levels of rivers, lakes, and reservoirs would fall. Serious economic stress to the livestock trade, industries, and cities would eventually result. Then if rainfall fell below the minimum needed for agriculture, crops would suffer drastic and rapid decline because there would be no reserve water in the soil. Such a situation, to some extent, occurred during the Northeast drought in the mid-1960's when New York City almost ran out of water.

A detailed explanation and examination of the index is given by Alley (1984). Both Alley and Karl (1983) address the sensitivity of the index and list some limitations.

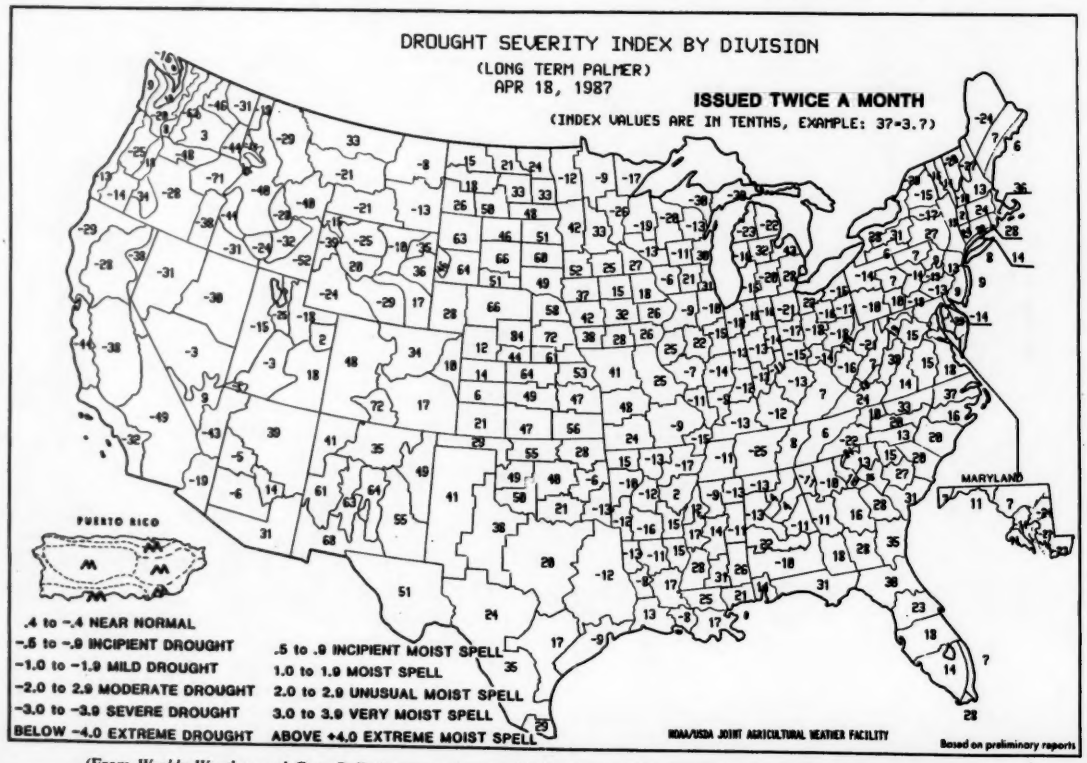
References:

Alley, W., 1984: "The Palmer Drought Severity Index: Limitations and Assumptions," *Journal of Climate and Applied Meteorology*, 23, 1100–1109.

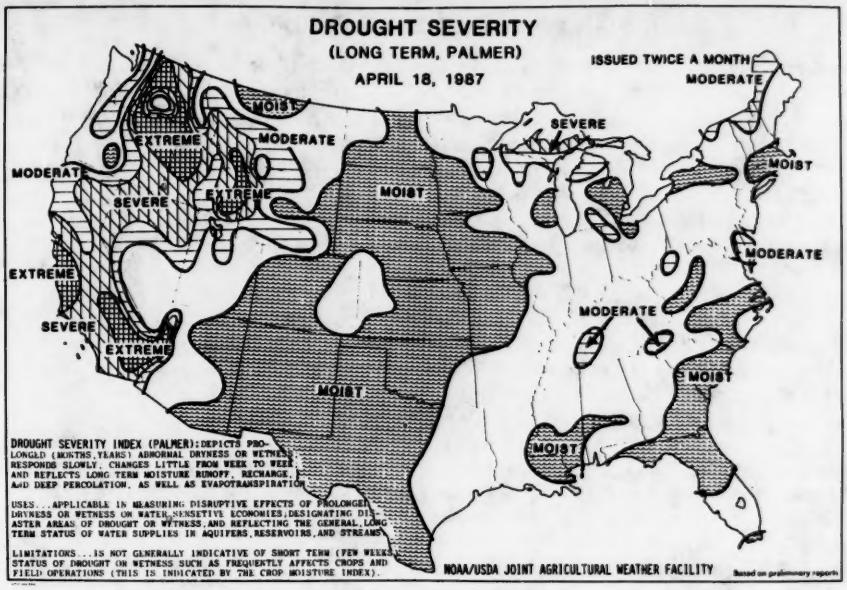
Karl, T.R., 1983: "Some Spatial Characteristics of Drought Duration in the United States," *Journal of Climate and Applied Meteorolgy*, 22, 1356–1366.

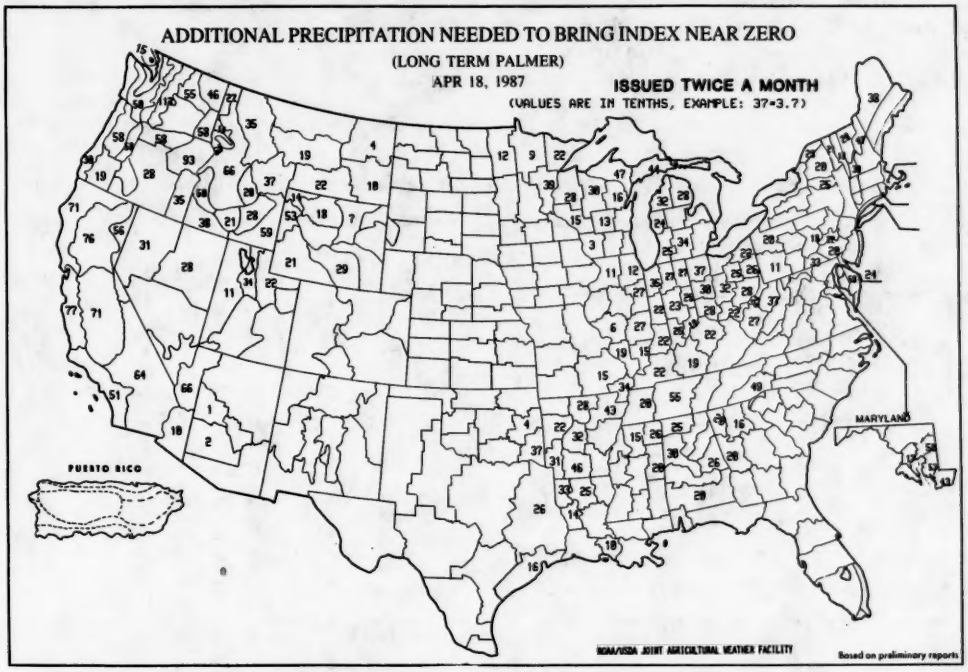
Palmer, W.C., 1965: *Meteorological Drought*, Weather Bureau Research Paper No. 45, U.S. Dept. of Commerce, Washington, DC, 58pp.

Thornthwaite, C.W., 1948: "An Approach Toward a Rational Classification of Climate," *Geographical Review*, 38, 55–94.


DROUGHT SEVERITY INDEX BY DIVISION
(LONG TERM PALMER)
APR 18, 1987
ISSUED TWICE A MONTH
(INDEX VALUES ARE IN TENTHS, EXAMPLE: 37=3.7)
PUERTO RICO
MARYLAND
.4 to -.4 NEAR NORMAL
-.5 to -.9 INCIPIENT DROUGHT
-1.0 to -1.9 MILD DROUGHT
-2.0 to 2.9 MODERATE DROUGHT
-3.0 to -3.9 SEVERE DROUGHT
BELOW -4.0 EXTREME DROUGHT
.5 to .9 INCIPIENT MOIST SPELL
1.0 to 1.9 MOIST SPELL
2.0 to 2.9 UNUSUAL MOIST SPELL
3.0 to 3.9 VERY MOIST SPELL
ABOVE +4.0 EXTREME MOIST SPELL
NOAA/USDA JOINT AGRICULTURAL WEATHER FACILITY
Based on preliminary reports

(From *Weekly Weather and Crop Bulletin* prepared and published by the NOAA/USDA Joint Agricultural Weather Facility)


DROUGHT SEVERITY
(LONG TERM, PALMER)
APRIL 18, 1987
ISSUED TWICE A MONTH
MOIST
MODERATE
SEVERE
EXTREME
DROUGHT SEVERITY INDEX (PALMER): DEPICTS PRO-LONGLD (MONTHS, YEARS) ABNORMAL DRYNESS OR WETNESS. RESPONDS SLOWLY, CHANGES LITTLE FROM WEEK TO WEEK, AND REFLECTS LONG TERM MOISTURE RUNOFF, RECHARGE, AnD DEEP PERCOLATION, AS WELL AS EVAPOTRANSPIRATION.
USES...APPLICABLE IN MEASURING DISRUPTIVE EFFECTS OF PROLONGED DRYNESS OR WETNESS ON WATER SENSETIVE ECONOMIES; DESIGNATING DISASTER AREAS OF DROUGHT OR WETNESS, AND REFLECTING THE GENERAL LONG TERM STATUS OF WATER SUPPLIES IN AQUIFERS, RESERVOIRS, AND STREAMS.
LIMITATIONS...IS NOT GENERALLY INDICATIVE OF SHORT TERM (FEW WEEKS) STATUS OF DROUGHT OR WETNESS SUCH AS FREQUENTLY AFFECTS CROPS AND FIELD OPERATIONS (THIS IS INDICATED BY THE CROP MOISTURE INDEX).
NOAA/USDA JOINT AGRICULTURAL WEATHER FACILITY
Based on preliminary reports


ADDITIONAL PRECIPITATION NEEDED TO BRING INDEX NEAR ZERO
(LONG TERM PALMER)
APR 18, 1987
ISSUED TWICE A MONTH
(VALUES ARE IN TENTHS, EXAMPLE: 37=3.7)
PUERTO RICO
MARYLAND
NOAA/USDA JOINT AGRICULTURAL WEATHER FACILITY
Based on preliminary reports

Additional Precipitation Needed to Bring the Drought Index to Near Zero

A parameter derived from the calculations of the Drought Severity Index is the additional precipitation in inches needed to bring the index to near zero. This parameter is computed for all values of the current week's index less than –.5 (the upper limit of an incipient drought) and left blank for all values greater than or equal to –.5. The precipitation values are theoretically the additional amounts required to end the drought defined by the index in each climatic division. In using this parameter to make projections, it must be realized that these values are instantaneous, valid only for the current week. To end the drought in a given climatic division for the oncoming week, the precipitation amount listed plus near-normal rainfall must occur.

(From *Weekly Weather and Crop Bulletin* prepared and published by the NOAA/USDA Joint Agricultural Weather Facility)

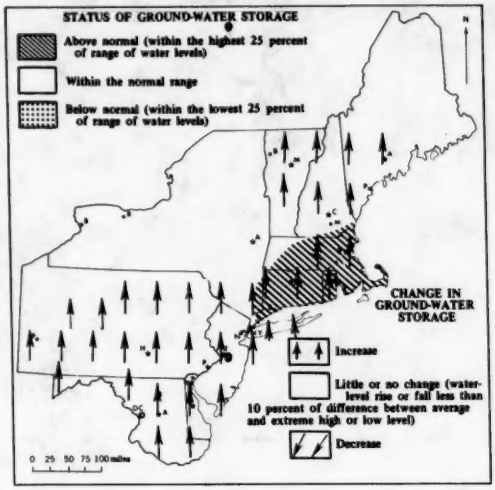
GROUND-WATER CONDITIONS DURING APRIL 1987

Ground-water levels continued to rise seasonally in most of the Northeast, including central and southern New England, New Jersey, Maryland, southeastern New York State, and most of Pennsylvania. (See map.) Levels near end of month were above average in southern New England—Connecticut, Rhode Island, and eastern and central Massachusetts. Elsewhere in the Northeast, ground-water levels were mainly within the normal range for the end of April.

In the Southeast, ground-water levels rose in West Virginia, Kentucky, Virginia, and North Carolina. Net water-level changes during the month were mixed in Arkansas, Louisiana, Mississippi, and Georgia. Water levels were above average in Kentucky, below average in Arkansas, and mixed with respect to average in West Virginia, Virginia, North Carolina, Louisiana, and Florida. New low levels for April were established in key wells in Memphis, Tennessee, and at Stuttgart, Arkansas. The new low in the Stuttgart well is the fourth consecutive low monthend level in this well.

In the central and western Great Lakes States, ground-water levels showed mixed changes in Minnesota, Michigan, Ohio, and Iowa. Water levels were below average in Indiana and Ohio, and mixed with respect to average in Minnesota, Michigan, and Iowa.

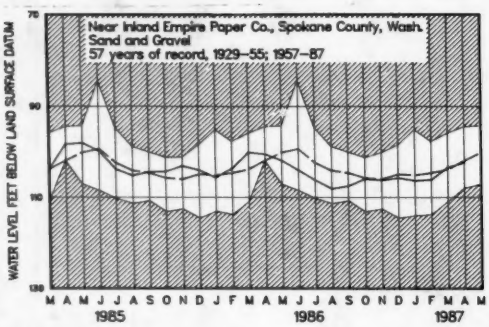
In the Western States, ground-water levels rose in North Dakota, and declined in southern California, Utah, and in most of the key wells in Idaho. Net changes in level during the month were mixed in Washington, Nebraska, Nevada, Kansas, Arizona, and Texas.

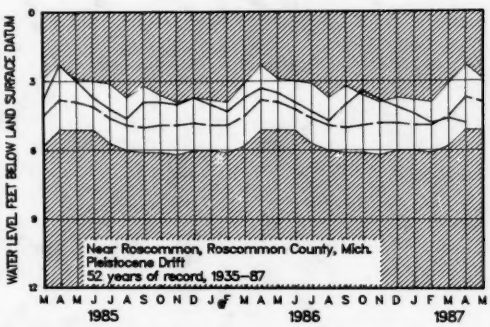

STATUS OF GROUND-WATER STORAGE
Above normal (within the highest 25 percent of range of water levels)
Within the normal range
Below normal (within the lowest 25 percent of range of water levels)
N
CHANGE IN GROUND-WATER STORAGE
Increase
Little or no change (water-level rise or fall less than 10 percent of difference between average and extreme high or low level)
Decrease
0 25 50 75 100 miles

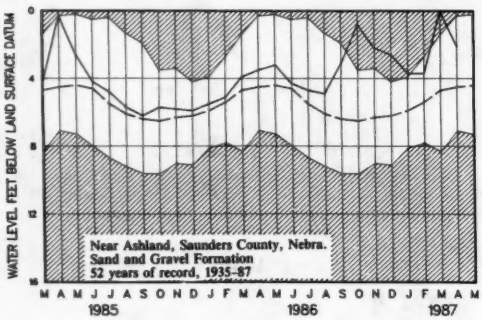
Map showing ground-water storage near end of April and change in ground-water storage from end of March to end of April.

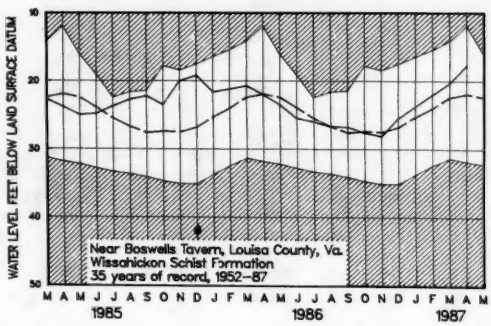
MONTH-END GROUND-WATER LEVELS IN KEY WELLS

Unshaded area indicates range between highest and lowest record for the month. Dashed line indicates average of monthly levels in previous years. Heavy line indicates level for current period.


Near Inland Empire Paper Co., Spokane County, Wash.
Sand and Gravel
57 years of record, 1929–55; 1957–87
WATER LEVEL, FEET BELOW LAND SURFACE DATUM
70
80
90
100
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M
1985
1986
1987


Near Roscommon, Roscommon County, Mich.
Pleistocene Drift
52 years of record, 1935–87
WATER LEVEL, FEET BELOW LAND SURFACE DATUM
0
3
6
9
12
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M
1985
1986
1987


Near Ashland, Saunders County, Nebra.
Sand and Gravel Formation
52 years of record, 1935–87
WATER LEVEL, FEET BELOW LAND SURFACE DATUM
0
4
8
12
16
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M
1985
1986
1987


Near Boswells Tavern, Louisa County, Va.
Wissahickon Schist Formation
35 years of record, 1952–87
WATER LEVEL, FEET BELOW LAND SURFACE DATUM
10
20
30
40
50
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M
1985
1986
1987

Water levels were above long-term averages in Nebraska, and mixed with respect to average in Washington, Idaho, North Dakota, southern California, Nevada, Utah, Kansas, Arizona, and Texas. New high ground-water levels for April were recorded in Nebraska, Nevada, and Kansas. New April low levels were reached in Nevada, Kansas, and Texas.

Provisional data; subject to revision

WATER LEVELS IN KEY OBSERVATION WELLS IN SOME REPRESENTATIVE AQUIFERS IN THE CONTERMINOUS UNITED STATES—APRIL 1987

Aquifer and Location	Water level in feet with reference to land-surface datum	Departure from average in feet	Net change in water level in feet since:		Year records began	Remarks
			Last month	Last year		
Glacial drift at Hanska, south-central Minnesota.	−6.43	−0.92	+0.67	−3.76	1942	
Glacial drift at Roscommon in north-central part of Lower Peninsula, Michigan.	−4.80	−1.01	−0.12	−1.49	1935	
Glacial drift at Marion, Iowa.....	−3.30	−0.03	−0.77	−0.50	1941	
Glacial drift at Princeton in northwestern Illinois.	−7.48	+0.20	+0.50	+0.50	1943	
Petersburg Granite, southeastern Piedmont near Fall Zone, Colonial Heights, Virginia.	−12.47	+1.80	+0.63	+2.17	1939	
Glacial outwash sand and gravel, Louisville, Kentucky (U.S. well no. 2).	−18.58	+6.34	+0.11	−1.10	1946	
500-foot sand aquifer near Memphis, Tennessee (U.S. well no. 2).	−105.39	−16.34	−0.10	−0.72	1941	April low.
Weathered granite, Mocksville area, Davie County, western Piedmont, North Carolina.	−15.13	+3.92	+2.57	+3.77	1932	
Sparta Sand in Pine Bluff industrial area, Arkansas.	−230.00	−22.97	−0.05	−11.90	1958	
Eutaw Formation in the City of Montgomery, Alabama (U.S. well no. 4).	−24.1	−6.0	−2.5	+0.7	1952	
Limestone aquifer on Cockspur Island, Savannah area, Georgia (U.S. well no. 6).	−32.60	−6.70	−1.81	+0.49	1956	
Sand and gravel in Puget Trough, Tacoma, Washington.	−100.90	+5.30	+0.42	−0.80	1952	
Pleistocene glacial outwash gravel, North Pole, northern Idaho (U.S. well no. 3).	−462.9	−1.6	+2.5	−1.2	1929	
Snake River Group: Snake River Plain Aquifer, at Eden, Idaho (U.S. well no. 4).	−122.6	−0.8	−0.2	+1.7	1957	
Alluvial valley fill in Flowell area, Millard County, Utah (U.S. well no. 9).	−13.91	−17.87	−6.87	−5.12	1929	
Alluvial sand and gravel, Platte River Valley, Ashland, Nebraska (U.S. well no. 6).	−2.17	+1.62	−2.20	+1.37	1935	
Alluvial valley fill in Steptoe Valley, Nevada....	−6.54	+5.81	−0.03	+0.20	1950	April high.
Pleistocene terrace deposits in Kansas River valley, at Lawrence, northeastern Kansas.	−15.27	+5.48	+1.15	+2.95	1953	April high.
Alluvial sand and gravel, Upper Cuyama Valley, Santa Barbara County, California (U.S. well no. 10)	−111.37	+0.34	−0.82	−11.91	1950	
Valley fill, Elfrida area, Douglas, Arizona (U.S. well no. 15).	−102.7	−22.2	−0.3	+2.1	1951	
Hueco bolson, El Paso area, Texas....	−266.58	−18.93	−1.81	−1.78	1965	April low.
Evangeline aquifer, Houston area, Texas.....	−310.24	−14.25	+0.57	−2.74	1965	

HYDROGEOLOGIC FRAMEWORK OF THE FLORIDAN AQUIFER SYSTEM IN FLORIDA AND IN PARTS OF GEORGIA, ALABAMA, AND SOUTH CAROLINA

The abstract and illustrations below are from the report, *Hydrogeologic framework of the Floridan aquifer system in Florida and in parts of Georgia, Alabama, and South Carolina*, by James A. Miller, U.S. Geological Survey Professional Paper 1403-B, 91 pages, 33 plates, 1986. This report may be purchased for $30.00 from the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 41, Box 25425, Denver, CO 80225.

ABSTRACT (abridged)

The Floridan aquifer system of the Southeastern United States (see figure 1) is comprised of a thick sequence of carbonate rocks that are mostly of Paleocene to early Miocene age and that are hydraulically connected in varying degrees. The aquifer system consists of a single vertically continuous permeable unit updip and of two major permeable zones (the Upper and Lower Floridan aquifers) separated by one of seven middle confining units downdip. Neither the boundaries of the aquifer system or of its component high- and low-permeability zones necessarily conform to either formation boundaries or time-stratigraphic breaks.

The rocks that make up the Floridan aquifer system, its upper and lower confining units, and a surficial aquifer have been separated into several chronostratigraphic units. The external and internal geometry of these stratigraphic units is presented on a series of structure contour and isopach maps and by a series of geohydrologic cross sections and a fence diagram. Paleocene through middle Eocene units consist of an updip clastic facies and a downdip carbonate bank facies, that extends progressively farther north and east in progressively younger units. Upper Eocene and Oligocene strata are predominantly carbonate rocks throughout the study area. Miocene and younger strata are mostly clastic rocks.

The uppermost hydrologic unit in the study area is a surficial aquifer that can be divided into (1) a fluvial sand-and-gravel aquifer in southwestern Alabama and westernmost panhandle Florida, (2) limestone and sandy limestone of the Biscayne aquifer in southeastern peninsular Florida, and (3) a thin blanket of terrace and fluvial sands elsewhere. The surficial aquifer is underlain by a thick sequence of fine clastic rocks and low-permeability carbonate rocks, most of which are part of the middle Miocene Hawthorn Formation and all of which form the upper confining unit of the Floridan aquifer system. In places, the upper confining unit has been removed by erosion or is breached by sinkholes. Water in the Floridan aquifer system thus occurs under unconfined, semiconfined, or fully confined conditions, depending upon the presence, thickness, and integrity of the upper confining unit.

Within the Floridan aquifer system, seven low permeability zones of subregional extent split the aquifer system in most places into an Upper and Lower Floridan aquifer. The Upper Floridan aquifer, which consists of all or parts of rocks of Oligocene age, late Eocene age, and the upper half of rocks of middle Eocene age, is highly permeable. The middle confining units that underlie the Upper Floridan are mostly of middle Eocene age but may be as young as Oligocene or as old as early Eocene. Where no middle confining unit exists, the entire aquifer system is comprised of permeable rocks and for hydrologic discussions is treated as the Upper Floridan aquifer (see figure 2).

The Lower Floridan aquifer contains a cavernous high-permeability horizon in the lower part of the early Eocene of southern Florida that is called the Boulder Zone. A second permeable unit that is cavernous in part, herein called the Fernandina permeable zone, occurs in the lower part of the Lower Floridan in northeastern Florida and southeastern Georgia. Both these permeable zones are overlain by confining units comprised of micritic limestone. The confining unit that overlies the Boulder Zone is of subregional extent and is mapped as a separate middle confining unit within the Lower Floridan.

Major structural features such as the Southeast and Southwest Georgia embayments, the South Florida basin, the Gulf Coast geosyncline, and the Peninsular arch have had a major effect on the thickness and type of sediment deposited in the eastern gulf coast. The effects of smaller structures are also evident. For example, the Gilbertown-Pickens-Pollard fault system in Alabama locally forms the updip limit of the Floridan aquifer system. The series of grabens that comprise the Gulf Trough of central Georgia serves as a low-permeability barrier to ground-water flow there. These Gulf Trough faults have downdropped low-permeability rocks opposite permeable limestones to create a damming effect that severely retards ground-water movement across the fault system. Their effect can be seen on potentiometric surface maps of the aquifer system. Other small-displacement faults in peninsular Florida do not appear to affect the regional flow system because there is no apparent change in the permeability of the rocks that have been juxtaposed by fault movement.

Variations in permeability within the Floridan aquifer system result from a combination of original depositional conditions, diagenesis, large- and small-scale structural features, and dissolution of carbonate rocks or evaporite deposits. Local permeability variations are accordingly more complex than the generalized regional portrayal presented in this report.

Figure 1. Location of the study area and the approximate updip limit of the Floridan aquifer system.

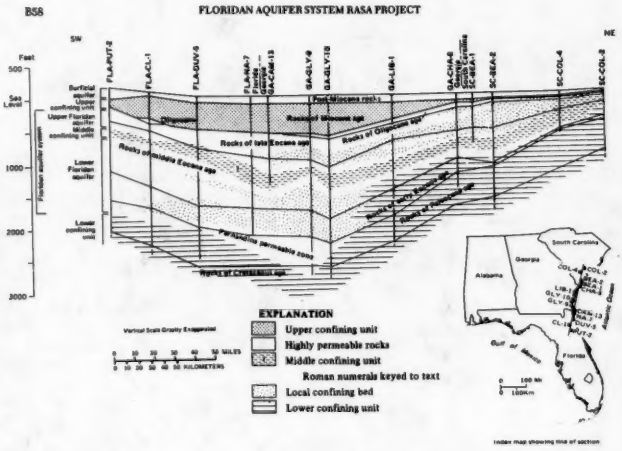
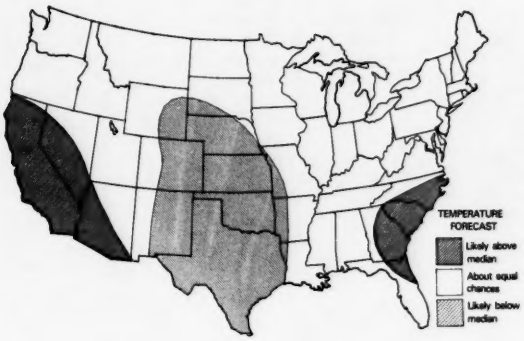


Figure 2. Generalized geohydrologic cross section from Putnam County, Fla. to Colleton County, S.C.

TEMPERATURE OUTLOOK FOR MAY THROUGH JULY 1987



PRECIPITATION OUTLOOK FOR MAY THROUGH JULY 1987

NATIONAL WATER CONDITIONS

APRIL 1987

Based on reports from the Canadian and U.S. Field offices; completed May 14, 1987

TECHNICAL STAFF

Thomas G. Ross, Editor
Carroll W. Saboe, Asst. Editor
John C. Kammerer
Allen Sinnott
Krishnaveni V. Sarma
Sharon A. Edmonds
Carole J. Marlow

COPY PREPARATION

Lois C. Fleshmon
Sharon L. Peterson
Aisha P.R. Law

GRAPHICS

Frances L. Buchanan
Carolyn L. Moss

The National Water Conditions is published monthly. Subscriptions are free on application to the U.S. Geological Survey, 419 National Center, Reston, VA 22092.

EXPLANATION OF DATA (Revised April 1987)

Cover map shows generalized pattern of streamflow for the month based on provisional data from 183 index gaging stations—18 in Canada, 163 in the United States, and 2 in the Commonwealth of Puerto Rico. Alaska, Hawaii, and Puerto Rico inset maps show streamflow only at the index gaging stations that are located near the point shown by the arrows. Classifications on map are based on comparison of streamflow for the current month at each index station with the flow for the same month in the 30-year reference period, 1951-80. Shorter reference periods are used for one Canadian index station, two Kansas index stations, one New York index station, and the Puerto Rico index stations because of the limited records available.

The *persistence/change* map shows where streamflow has persisted in the above- or below-normal range from last month to this month and also where streamflow is in the above- or below-normal range this month after being in a different range last month. The table below the map shows areal streamflow range conditions for all index stations reporting data for this month and compares total flow of the stations reporting data for both last month and this month.

The comparative data are obtained by ranking the 30 flows for each month of the reference period in order of decreasing magnitude—the highest flow is given a ranking of 1 and the lowest flow is given a ranking of 30. Quartiles (25-percent points) are computed by averaging the 7th and 8th highest flows (upper quartile), 15th and 16th highest flows (middle quartile and median), and the 23rd and 24th highest flows (lower quartile). The upper and lower quartiles set off the highest 25 percent of flows and lowest 25 percent of flows, respectively, for the reference period. The median (middle quartile) is the middle value by definition. For the reference period, 50 percent of the flows are greater than the median, 50 percent are less than the median, 50 percent are between the upper and lower quartiles (in the normal range) 25 percent are greater than the upper quartile (above normal), and 25 percent are less than the lower quartile (below normal). Flow for the current month is then classified as; *above normal* if it is greater than the upper quartile, *in the normal range* if it is between the upper and lower quartiles, and *below normal* if it is less than the lower quartile. Change in flow from the previous month to the current month is classified as *seasonal* if the change is in the same direction as the change in the median. If the change is in the opposite direction of the change in the median, the change is classified as *contraseasonal* (opposite to the seasonal change). For example: at a particular index station, the January median is greater than the December median; if flow for the current January increased from December (the previous month), the increase is seasonal; if flow for the current January decreased from December, the decrease is contraseasonal.

Flood frequency analyses define the relation of flood peak magnitude to probability of occurrence or recurrence interval. *Probability of occurrence* is the chance that a given flood magnitude will be exceeded in any one year. *Recurrence interval* is the reciprocal of probability of occurrence and is the *average* number of years between occurrences. For example, a flood having a probability of occurrence of 0.01 (1 percent) has a recurrence interval of 100 years. *Recurrence intervals imply no regularity of occurrence;* a 100-year flood might be exceeded in consecutive years or it might not be exceeded in a 100-year period.

Statements about *ground-water levels* refer to conditions near the end of the month. The water level in each key observation well is compared with average level for the end of the month determined from the 30-year reference period, 1951-80, or from the entire past record for that well when only limited records are available. Comparative data for ground-water levels are obtained in the same manner as comparative data for streamflow. *Changes in ground-water levels,* unless described otherwise, are from the end of the previous month to the end of the current month.

Dissolved solids and temperature data for April are given for five stream-sampling sites that are part of the National Stream Quality Accounting Network (NASQAN). *Dissolved solids* are minerals dissolved in water and usually consist predominately of silica and ions of calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulfate, chloride, and nitrate. *Dissloved-solids discharge* represents the total daily amount of dissolved minerals carried by the stream. *Dissolved-solids concentrations* are generally higher during periods of low streamflow, but the highest dissolved-solids *discharges* occur during periods of high streamflow because the total quantities of water, and therefore total load of dissolved minerals, are so much greater than at times of low flow.

☆ U.S. Government Printing Office: 1987—181-401/60003

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
NATIONAL CENTER, STOP 419
RESTON, VIRGINIA 22092

OFFICIAL BUSINESS

Return this sheet to above address, if you do NOT wish to receive this material ☐, or if change of address is needed ☐ (indicate change, including ZIP code).

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF THE INTERIOR
INT 413

FIRST CLASS

SPECIAL PROCESSING DEPT
MARCIA KOZLOWSKI
XEROX/UNIVERSITY MICROFILMS
ANN ARBOR MI 48106

NWC